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A GUIDE TO SAND DUNE PLANTS OF SOUTH-WESTERN AUSTRALIA

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Australia.

The coast of Western Australia for many miles north and south of Perth is bordered by sand dunes with occasional outcroppings of limestone cliffs. A distinctive maritime flora occupies the narrow fringe of these mobile dunes and is succeeded inland by the sclerophyllous flora on old and stable dunes.

The area of shore from which this description is drawn extends for about 20 miles north and south of Perth. Its dune flora is, however, fairly representative of that of many miles of western shoreline. This description is limited to the species of the mobile dunes of this area.

THE DUNE LANDSCAPE

In the apparent wilderness of the dune landscape there is to be found a basic pattern in the topography and in the distribution of the vegetation from the beach back into the hinterland.

The beach sand brought to the shore by currents and wave action consists of a small fraction of quartz and other heavy minerals and a large fraction of water-worn calcareous fragments of skeletal parts of marine organisms. There is also a very small but not unimportant fraction of organic material derived from cast up seaweed and animal remains.

The prevailing onshore wind carries the beach sand landwards where obstacles such as stone, seaweed drift and dune plants, check the stream of moving sand grains, causing them to accumulate on the windward and still more on the leeward side of the obstruction. With obstacles of fixed height and width such as stones, the arrested sand can build up no higher than the height of the object, but with dune plants which grow upwards and radially as they are buried, the accumulation of sand increases in height and width until checked by other causes. In this way the dunelands are built up about the open communities of maritime plants and may reach a height of about 80 feet in the vicinity of Perth.

A low ridge of sand or *foredune* often develops among plants growing down to high-water mark of storm tides. This line of dunes is succeeded by the higher system of *mobile dunes*, the two systems often being separated by a depression. The mobile dunes are much dissected by erosion into a pattern of hills and hollows

determined by the protective cover of plants and the direction and duration of winds. In this region with its large expanse of bare sand and sparse plant cover the topography is constantly changing and stability is only reached behind the mobile dunes where the shelter afforded by their height permits the vegetation of the coastal heath to form a more continuous cover on the so-called *stable dunes*.

Wherever wind erosion has greatly disturbed the plant cover, long sandy troughs or *blow-outs* cut across the dunelands carrying drift sand inland to overwhelm the coastal heath and so form *wandering dunes*.

THE VEGETATION

Foredunes

Two species of strand plants colonise the beaches. They are *Cakile maritima* and *Arctotheca nivea*. Both are often abundant on beaches between high-water mark and the foredunes where their fruits have been carried by winter tides. They readily accumulate sand in the spring and summer, but their dune-building action here is only ephemeral as they are annuals or biennials within the reach of the storm tides.

The first perennial colonisers and principal builders of the foredunes are the grasses, *Spinifex hirsutus* and *S. longifolia*. The former dominates foredunes of exposed shores down to the level of the storm tides, while the latter occurs further back in the mobile dunes except on sheltered shores, such as those of mainland bays and nearby islands, where it grows thickly down to high-water mark. *Ammophila arenaria*, a naturalised grass, also contributes to the building of both fore- and mobile dunes in the vicinity of Perth. *Cakile* and *Arctotheca* are also common in these open grass communities.

Mobile Dunes

In sheltered hollows behind the foredunes there is a greater variety of maritime plants. The species most commonly occurring are *Tetragonia zcyheri*, *Scirpus nodosus*, *Calocephalus brownii*, *Carpobrotus aequilaterus* and *Spinifex longifolia*. Not so abundant are *Angianthus cunninghamii*, *Pelargonium drummondii*, *Anthericum divaricatum* and *Senecio lautus*. More rare and confined to this region are *Sonchus megalocarpus* and *Atriplex isatidea*.

Towards the crests of these dunes the plant cover becomes closer and mainly consists of the larger shrubs, *Myoporum insulare*, *Scaevola crassifolia*, *Olearia axillaris*, *Acacia cyclopis* and the spreading clumps of *Lepidosperma gladiatum*. This low, wind-pruned shrubbery becomes taller and more luxuriant on the sheltered landward side of the mobile dunes, where dense thickets of *Pelargonium* and *Lepidosperma* and other shrubs fill the hollows in the transition area between these dunes and the coastal heath of the stable dunes.

DUNE PLANTS AND THEIR ENVIRONMENT

The seashore environment is a harsh one. The low fertility of the sand, its low humus content, low water holding capacity and

above all its instability prevent many species of the country flora from becoming established there.

Wherever sand drift has been prevented (usually in attempts to protect coastal improvements) by systems of wind breaks and plantings of selected maritime plants, natural colonisation by maritime species, weeds and heath plants has slowly followed without resource to artificial watering or application of fertilisers. Such attempts at stabilisation prove the importance of the instability factor. The colonisation of loose sand is most seriously limited by the erosion, burial and sand blast of pioneer plants in their tender seedling stages. Even the survival of seedlings of maritime species which are highly adapted to their environment depends largely, in their early stages at least, on the length of growing time before they are subjected to the rigours of a sand-storm.

In dunclands undisturbed by man the succession of species which leads to a heath vegetation on stable soil is being set back repeatedly by the seasonal ravages of wind and moving sand so that the open maritime community is maintained for very long periods of time. That this succession is taking place very slowly is evident if we observe the changes in the plant cover from the high-tide mark back into the hinterland. In places the coastal heath is advancing seaward and succeeding the maritime community by invasion and competition. In other places the mobile dunes are overwhelming the heath and the succession starts afresh on the loose sands of the wandering dunes.

Dune plants assume a variety of growth habits or life-forms, but three types of habit predominate. There are the rhizomatous plants with considerable power of lateral and vertical growth; the prostrate mat shrubs and erect shrubs kept down to low spreading bushes by wind pruning.

The rhizome habit of *Spinifex*, *Scirpus*, *Ammophila* and *Lepidosperma* enables these species to stabilise large areas of sand by their laterally spreading foliage and to survive burial by the rapid vertical growth of their leafy shoots. The rhizomes also grow at successively higher levels in the accumulated drift and the matrix of fine roots produced from their nodes hinders the removal of sand should the plant become subject to erosion.

The mat habits of *Tetragonia*, *Carpobrotus*, *Scaevola* and *Cakile* protect considerable areas of sand surface. The prostrate foliage also acts as a trap for low drifting sand so that accumulation adds to the stability of the plant and the protection of its tap root system.

Woody species with an erect habit are kept stunted by wind pruning but spread laterally, mostly on their sheltered sides, protecting the sand from further erosion. *Olearia*, *Myoporum* and *Acacia* assume this modified life-form in exposed situations with obvious dune-building effect.

Other notable features of dune plants include their extensive root systems and the prevalence of succulent foliage.

There is no experimental data available on the water relationships and succulence of local dune plants so it is impossible at present to discuss how they fare for water throughout the long dry summer. However, the perennial species show little outward evidence of suffering from drought and the majority of them remain green and succulent throughout the summer months in contrast to the shrivelled appearance of many sclerophyllous plants of the coastal heath. It is very likely that their deep root systems find ample water supplies in a habitat so close to sea level where the water table is at no great depth.

Over half of the dune species have succulent foliage containing varying amounts of water-storage tissue. This prevalence of succulence contrasts with the lack of it in the sclerophyllous vegetation further inland. Succulent plants are common again in the saline soils of the more arid interior.

The most extreme examples of succulence in the dunelands are the leaves of *Carpobrotus* consisting largely of water storage parenchyma, and the fleshy leaves of *Tetragonia* with their epidermal cells much inflated by stored water. It is this succulence of both leaves and stems which makes the pressing and drying of herbarium specimens of dune plants such a slow process. The fresh specimens should be steeped in boiling water for ten minutes to kill the tissues and remove much of the salt and so speed up the release of water from the cells to the drying papers in the press.

There is much experimental evidence to suggest that plants growing in saline soils may become succulent as a result of the chemical effect of a high concentration of sodium chloride on the physiology of the tissues, promoting the development of water-storage parenchyma. The resulting succulence is not necessarily related to water shortage as was formerly supposed, but should these plants become subjected to drought their succulence may well alleviate their water shortage.

Some species, e.g., *Senecio laetus* become more succulent the nearer they grow to the sea while others, e.g., *Spinifex longifolia*, although salt tolerant, show no variation in succulence over their range of distribution back from the shore.

The geographical distribution of the species under discussion is interesting for it shows that most of these plants although restricted to the dunelands are widely spread along the seashores of Australia, while some are common to the shores of Australia and other continents.

Atriplex, *Olcara*, *Caloccephalus*, *Carpobrotus*, *Lepidosperma*, *Myoporum*, *Pelargonium* and *Spinifex hirsutus* occur in dunes from Western Australia to Victoria. *Anthericum*, *Arctotheca*, *Sonchus* and *Tetragonia* are common to South Africa and South-Western Australia. *Arctotheca* is known to be a recent migrant to our shores and *Anthericum* is perhaps a recent introduction. *Cakile* and *Salsola* are widely spread along shores of Europe and Asia, the latter also growing on saline soils of inland areas much as it does in

Australia. *Spinifex longifolia* extends from Northern Australia down the west coast to the Swan River. The only species with relatively limited distributions are *Angianthus*, an endemic of the west coast and *Acacia* and *Scaevola* which extend from the south-west coast to South Australia.

FIELD KEY TO SPECIES

1. Plants rhizomatous with leafy shoots and fibrous roots from each node (sedges, rushes and grasses) 2
1. Plants not as above 5
2. Erect shoots or "leaves" terete. Flower heads globose, brown **Scirpus nodosus** 3
2. Leaves not terete 3
3. Leaf lamina semi-circular in section. Flower heads globular and bristly **Spinifex longifolia** 4
3. Leaf lamina long and thin 4
4. Lamina about 3 cm. broad, glabrous, dark green. Flowers in persistent panicles, dark brown **Lepidosperma gladiatum**
4. Lamina about 3 cm. broad, with silky, silvery pubescence. Flower heads globular and bristly **Spinifex hirsutus**
4. Lamina about 1 cm. broad, glabrous, much inrolled in dry weather. Flowers in straw-coloured spikes **Ammophila arenaria**
5. Woody shrubs or undershrubs with erect or decumbent branches 6
5. Herbaceous plants, mostly with succulent stems and leaves 12
6. Foliage green, never grey or white 7
6. Foliage always grey or white 10
7. Leaves glabrous 8
7. Leaves pubescent 9
8. Leaves linear-lanceolate, thin, the tip hooked laterally. Flower heads stalked, axillary, globular and yellow (Wattle) **Acacia cyclops**
8. Leaves ovate-lanceolate, fleshy, sweetly aromatic. Flowers 2-6 axillary, white. Fruit a purple berry **Myoporum insulare**
8. Leaves orbicular, fleshy, edges serrated, viscid when young. Flowers in spikes, pale blue **Scaevola crassifolia**
9. Leaves stipulate, orbicular-reniform, edges crenellated. Flowers in umbels, pink **Pelargonium drummondii**
9. Leaves ex-stipulate, oblanceolate-ovate, entire or remotely toothed. Flowers solitary, large yellow **Oenothera drummondii**
10. Leaves with ash-grey scaly tomentum. Fruit a small nut enclosed by two grey rhomboidal bracts **Atriplex isatidea**
10. Leaves with fine grey or white tomentum 11
11. A rigidly much branched undershrub. Leaves narrow, pressed against the stem. Flowers in terminal, globular heads **Calocephalus brownii**
11. A sparsely branched, slender undershrub. Leaves narrow and spreading. Flower heads in racemes. Flowers deep yellow **Angianthus cunninghamii**
11. An erect shrub with close, aromatic foliage. Leaves narrow, crowded. Flower heads axillary, sessile. Flowers, greenish-yellow. **Olearia axillaris**
12. Stem a tuberous root-stem stock with a crown of leaves at ground level 13
12. Stem branching above ground 14
13. Leaves lobed to pinnatifid, prickly toothed. Flowers in heads, yellow **Sonchus megalocarpus**
13. Leaves strap-like, 0.5 cm. broad, straggling and succulent. Flowers in much branched racemes, white **Anthericum divaricatum**
14. Main stems prostrate, ascending at the tips 15
14. Main stems ascending, not prostrate 18
15. Leaves opposite, 3-sided, succulent **Carpobrotus aequilaterus**
15. Leaves alternate 16
16. Leaves broad, entire or slightly lobed but not dissected 17
16. Upper leaves narrow-linear, much lobed or dissected. Flowers in terminal racemes, lilac coloured **Cakile maritima**



Fig. 2.—*Spinifex hirsutus*



Fig. 1.—*Spinifex longifolia*



17. Leaves green, rhomboidal-linear, with papillose surface of water-storage cells. Flowers 1-4, axillary, greenish yellow ... *Tetragonia zeyheri*
17. Leaves in large rosettes, grey-white. Flower heads yellow, daisy-like on stout axillary stalks ... *Arctotheca nivea*
18. Stems much branched to give a rigid, prickly bush. Leaves short and thick, tipped with a stiff spine. Flowers axillary, greenish and membranous ... *Salsola kali*
18. Stems loosely branched and ascending to corymbs of daisy-like, yellow flower heads. Leaves variable, from linear entire to deeply pinnatifid ... *Senecio laetus*

Spinifex longifolia (Fig. 1)

Gramineae

A stout perennial grass restricted to the dunelands. Rhizome much branched with erect shoots forming large spreading thickets. Leaves ensheathing the stem in their lower half, the leaf sheath thin, papery and truncated, and fringed with silky hairs where it expands to the free leaf blade. Blade long, glabrous, semi-circular in section, slightly channelled on the upper face and finely grooved on the lower or outer face. Plants dioecious. Flowers in closely clustered racemes interspersed with numerous papery bracts to form bristly, globular heads. Female heads more bristly than males, about 10 in. in diameter on maturity, falling from their stalks when dry and distributed by wind, releasing seeds gradually. Flowers: May-June. Fruits maturing in December.

Spinifex hirsutus (Fig. 2)

Gramineae

A perennial grass of the foredunes with stout rhizomes or "runners" buried in the drift sand, and erect shoots bearing silky and silvery leaves. Leaves ensheathing the stem for some distance then expanding to the free blade. Blades long and flat, up to 3 em. broad, with a complete cover of short, silky hairs on both surfaces and outer side of sheath. Plants dioecious. Flower heads very similar to *S. longifolia* but finely pubescent. Flowers: June-July. Fruits maturing in summer.

The four species of the genus *Spinifex* are restricted to the seashores of Asia and Australia. Of the two species found in this State, *S. longifolia* extends from Northern Australia down to the Swan River, while *S. hirsutus* encircles the continent and extends to New Caledonia and New Zealand.

On our exposed shores, *S. hirsutus* is most abundant just above high-water mark of winter tides where it builds the foredunes. *S. longifolia* is mostly concentrated in the mobile dunes, except on sheltered shores such as the eastern and northern shores of Rottnest and Garden Islands, where it often grows thickly down to high-water mark.

The predominant grasses of the so-called 'spinifex country' of the more arid parts of Western Australia belong to the genus *Triodia* and not *Spinifex*, although the spiny nature of some of them would more appropriately qualify them for the name *Spinifex* — 'thorn maker' in allusion to the pungent leaves of the Asiatic species, the first to be described.



Fig. 5.—*Lepidosperma gladiatum*



Fig. 6.—*Anthericum divaricatum*



Ammophila arenaria (Marram Grass) (Fig. 3) Gramineae

A perennial grass with much branched rhizomes and fine fibrous roots. Erect shoots often much buried in drift sand. Leaves up to 3 ft. long and 1 cm. broad, ending in a sharp point; upper or inner surface finely grooved and glaucous, lower or outer surface green, shiny and smooth. Leaves much inrolled in dry weather to give a tubular effect. Flower spikelets in long, cylindrical, straw-coloured spikes on stalks much exceeding the foliage. Flowers: Spring.

Marram Grass is native to the sand dunes of the western coasts of Europe where it is also widely hand propagated to stabilise wandering dunes. Introduced into Australia for this purpose, it has proved more successful than any native species in arresting coastal sand drift.

Considerable areas of wandering dunes between Swanbourne and Fremantle, and in the Albany and Warren River districts were engulfing valuable hinterland until arrested by plantings of *Ammophila*. The local method of propagation is to plant shoots in rows spaced about 3 ft. 6 in. apart and set at right angles to the prevailing wind. The grass thrives in mobile beach sands and readily grows through deep fresh sand drifts so that a well-established tussock may accumulate a pile of sand to a depth of eight feet in the course of a year. The extensive fibrous root system and much branched rhizome growing at successively higher levels in the accumulating sand, increase the stability of the arrested drift against wind erosion.

With stabilisation of the sand other dune species appear in the shelter of the *Ammophila* community. The changing environment brought about by the plant competition, together with the changes in soil conditions inherent in stabilisation and colonisation, causes the Marram Grass to die out. Such change in the Marram Grass community is seen at Swanbourne where *Acacia cyclops*, *Pelargonium drummondii* and other shrubs have succeeded the *Ammophila* plantings and developed a thick dune scrub in which many of the dead tussocks of *Ammophila* still persist.

Scirpus nodosus (Knotted Club Rush) (Fig. 4) Cyperaceae

The persistent and distinctive fruiting stems of this rush are readily recognisable throughout the year in sand dunes, on limestone cliffs and about the edge of salt marshes or inland waters. It is a species common to South Africa, Australasia, New Zealand and South America.

Rhizomes radiating, bearing fibrous roots and erect shoots at close intervals. Erect shoots rigid, terete, up to 24 in. and 3 mm. diameter, pungent pointed. Leaves reduced to papery sheaths about the base of the shoots. Flowers in globular heads, about 1.5 cm. diameter, at the top of the erect stems, subtended by a stout bract which appears to be a continuation of the stem. Flowers inconspicuous, surrounded by a system of small brown bracts. Flowers: September-December. Fruiting heads persistent.

Lepidosperma gladiatum (Coast Sword Sedge) (Fig. 5)
Cyperaceae

The stiff sword-like leaves and persistent flower spikes readily distinguish this maritime sedge from other dune plants. It is most abundant in hollows behind the mobile dunes, and along the crests of the dunes.

Stems subterranean, bearing closely packed erect shoots to form dense thickets. Leaves sword-like, biconvex, up to 3 cm. broad and razor-edged. Flowering stems similar to leaves but thicker, bearing a dense panicle of flowers. Flowers inconspicuous, surrounded by a series of light brown bracts darkening with age, on the persistent panicles. Flowers: Spring. Fruit a nut.

Anthericum divaricatum (Fig. 6) Liliaceae

A native of coastal sands of the Cape Peninsula, South Africa. It is very likely a recent natural migrant to our coast and certainly it has become most abundant in the dunelands in the last ten years.

Stem tuberous, subterranean, bearing a dense crown of prostrate straggling foliage. Leaves strap-like, 0.5 cm. or more broad, leathery, deep-green and orange towards the base. Inflorescence borne on a stout peduncle, much branched, rigid, up to 2 ft. Flowers in racemes, greenish-white. Perianth lobes, 6, recurved, with a bronze stripe down the centre and a yellow spot towards the base. Flowers: June-September. Mature fruiting inflorescence rolls about in the wind dispersing seeds from the capsular fruits.

Atriplex isatidea (Coast Saltbush) (Fig. 7) Chenopodiaceae

This *Atriplex* is very sparsely distributed along the mobile dunes to which it is restricted. An erect, loosely branched shrub with distinctive ashen foliage and cream-grey bark on the main branches. Old plants up to 10 ft. with a distinct tree habit are occasionally encountered. Leaves fleshy, entire, ellipsoidal, about 5 cm. long, with a close ash-grey to white scaly tomentum. Flowers inconspicuous, in small globular clusters on much-branched, terminal panicles. Flower clusters predominantly male or female, but often a mixture of both. Flowers: December-January. Mature fruit nut-like, enclosed between two rhomboidal bracts united in their lower half, about 8 mm. long, greyish-white, flushed with pink and bearing one or two irregular teeth or horns from their convex surfaces. Mature fruits, May-June.

Salsola kali (Prickly Saltwort) (Fig. 8) Chenopodiaceae

Salsola is not a common plant in the dunelands but it may be locally abundant on sheltered beaches where its fruits have accumulated from tidal and wind drift. It often features early in the plant succession on dunelands which have been levelled or otherwise disturbed.

An annual or perennial growing up to 3 ft. in a rigid, densely branched, symmetrical bush. Both stems and leaves are fleshy with a particularly glassy surface in vigorously growing plants. Leaves

stem-clasping, arching away from the stem and ending in a stiff spine, about 1 cm. long, semi-circular in section. Flowers solitary in the axil between the stem and a group of three leaves, inconspicuous and green. Perianth lobes 5, pale green, developing a conspicuous horizontal, membranous expansion which persists about the developing nut-like fruit to give an overall false fruit about 1 cm. diameter. Flowers: Spring.

Salsola is a cosmopolitan species occurring on saline soils of the more temperate regions of the world. In Australia it occurs on both the seashore and salty tracts well into the arid interior.

Like many maritime plants, *Salsola* accumulates considerable amounts of alkaline salts in its sap; so much so that in Europe it was formerly collected and burnt to obtain soda from the ash for the manufacture of glass and soap. The plant is well named: *Salsola*, from Latin, *salsus*, salted; and *kali*, from an Arabic word originally meaning the calcined ashes of *Salsola* and *Salicornia*, and afterwards transferred to these plants themselves as a vernacular name.

Tetragonia zeyheri (Sea Spinach) (Fig. 9) Aizoaceae

A widely spreading mat plant with flexible prostrate stems bearing numerous erect succulent shoots. Leaves succulent, glistening with surface water-storage cells, triangular ovate, tapering to the leaf stalk. Flowers 1-4 axillary with 4 spreading greenish-yellow perianth lobes. Stamens numerous. Styles 4. Mature fruit leathery and nut-like, sub-globular with four prominent ribs or angles extending up to the persistent perianth lobes.

This plant is edible but much inferior to the garden spinach, *Spinacea oleracea* (Chenopodiaceae). The long-lived plants of *Tetragonia* thrive in the path of drifting sand where fresh and rapid growth follows each light burial. Its habit and immense root system holds the plant fast in the fiercest wind erosion in blow-outs.

Carpobrotus aequilaterus (Pig-face) (*Mesembryanthemum aequilaterale*) Aizoaceae

A common mat plant of the mobile dunes and limestone cliffs. Stems stout, prostrate. Leaves opposite, joined at the base about the stem, succulent, triangular in section, glaucous green and pink on withering. Flowers solitary within the small terminal pair of leaves. Perianth lobes 4, succulent. Petals numerous, brilliant cerise pink, grading into the numerous stamens. Styles 8-10. Flowers: September-October. Fruit succulent, with 8-10 loculi containing numerous seeds in much mucilage; edible.

This species is indigenous to the seashores of Australia and should not be confused with the more familiar *Carpobrotus edulis*, "the Hottentot Fig" or "Pig-face" introduced from South Africa and become naturalised on the coastal plain about Perth. *C. edulis* has thicker and longer dark green leaves and larger flowers ranging from yellow to flesh pink but never cerise.



Fig. 10.—*Cakile maritima*



FIG. 12. *Mesembryemum inaequalis*



Fig. 9.—*Tetragonia zeyheri*



FIG. 11. *Convolvulus zeyheri*

Cakile maritima (Sea Rocket) (Fig. 10) Cruciferae

The genus *Cakile* has four species, all of which are maritime plants. Three species, including *C. maritima*, inhabit sandy shores of Europe, North Africa, Western Asia and Australia, while *C. arabica* is endemic to the shores of Central Arabia. The generic name is derived from *quaquilleh*, the Arabic name of *C. arabica*. On our shores the Sea Rocket is most abundant on beaches just about high-water mark of storm tides, or along drift slopes of blow-outs.

A smooth and succulent low spreading annual or perennial. Leaves fleshy, sessile, oblong, varying from entire to much lobed or dissected. Flowers in terminal racemes. Petals 4, lilac-coloured, stamens 6. Flowers: throughout the year. Fruit a constricted pod, the lower half top-shaped, with two slight horns, the upper portion spindle-shaped. A single seed in each portion. Unlike most crucifers the pod does not open to release the seed but the two portions of the fruit fall separately from the stalk and are dispersed by tide and wind. The seed germinates through the fruit wall.

Acacia cyclops Leguminosae-Mimosoideae

This coastal wattle is common in dunelands, on limestone outcrops and limestone soils of the coastal plain. In exposed situations the pruning effect of wind produces low spreading shrubs, while in sheltered stations it is more tree-like with several spreading main branches bearing a canopy of foliage often reaching down to the ground.

Leaves oblong-lanceolate, the tips hooked laterally, up to 9 cm. by 1 cm. Three veins usually more prominent than the rest. Flower heads, 2 or 3 on short stalks in the axil of the leaf, globular, 5 mm. broad. Flowers, minute, numerous, yellow. Flowers: December-March. Fruit, a typical legume or pod, curved and becoming much twisted on drying and opening. Seeds shiny black, encircled by a bright orange-red seed stalk in a double fold.

Pelargonium drummondii Geraniaceae

This "wild geranium" is indigenous to maritime sands about Australia. It occurs in great abundance in parts of the coastal heath, especially on limestone soil, but is equally at home in hollows of the mobile dunes.

A perennial undershrub with stout spreading stems and softly hairy foliage. Leaves ovate-ovate or reniform, about 6 cm. broad with several lobes and crenellated edges; leaf surface softly hairy, like the young stems; stipules stem clasping. Flowers, 4-20 in an umbel on a stiff peduncle, sepals 5, prominent and hairy; petals 5, pink streaked with red. Flowers: August-October. Fruits distinctive, each of the five carpels splitting on maturity to release the seed enclosed in the outer portion of the carpel which becomes spirally twisted and fringed with spreading silky hairs.

Named for James Drummond, a farmer and botanist in colonial Western Australia from 1829 to 1863, whose large collections and notes of the native flora made an invaluable contribution to the world's knowledge of Western Australian plants.



Fig. 14.—*Olearia acillaris*



Fig. 13.—*Scaevola crassifolia*



Oenothera drummondii (Evening Primrose) (Fig. 11)
Onagraceae (Oenotheraceae)

This garden escape, a native of coastal Texas, is spreading on drift sands in the Cottesloe and City Beach districts. It has become naturalised along the shores of several countries.

A low bushy perennial with sparsely branched stems. Leaves simple, oblanceolate to ovate, entire or remotely toothed, up to 5 em. long, but variable in size, softly pubescent. Flowers large, yellow, solitary and axillary. Flower buds erect; calyx-tube 2-4 em. long, pubescent, the four free calyx lobes 2-3 cm. long and reflexed in pairs. Petals four, obovate, 3 em. long, opening at night and withering to reddish yellow next day. Stamens 8. Style with four prominent lobes. Flowers: Summer. Fruit a capsule, 3-4 em. long, cylindrical and ribbed, curved. Seeds brown and fusiform.

Named for Thomas Drummond, a Scottish botanist who collected in North America, died 1835.

Myoporum insulare (Boobialla) (Fig. 12) Myoporaceae

A large spreading shrub most common towards the crests of the mobile dunes on both their exposed and sheltered slopes.

Leaves alternate, mostly ovate-lanceolate up to 7 em. long, fleshy, minutely glandular and sweetly aromatic. Leaf edges entire or with a few serrations. Flowers 2-6 axillary, eup-shaped, 6 mm. diameter, corolla of five white petals united in their lower half, finely hairy within. Stamens usually 4 or less by abortion. Anthers purple when fresh, fading to brown. Flowers: Spring. Fruit a succulent berry, dark purple and about 7 mm. diameter when ripe.

Scaevola crassifolia (Fig. 13) Goodeniaceae

A low, wide-spreading undershrub restricted to mobile dunes and limestone cliffs near the sea in south-western Australia and South Australia. Leaves more or less orbicular with serrated edges, deep green, fleshy, finely glandular, the viscid secretion of the young foliage often with much sand adhering. Flowers in terminal spikes, pale blue and sweetly scented. Corolla tube 5-lobed and split to the base on the inner side, a character typical of the genus and one which suggested the name *Scaevola*—a Roman family name, meaning "left-handed" from *scaevus*, left; alluding to this one-sided fan-like corolla. Stamens 5, soon withering. Style with terminal purse-like eup or indusium enclosing the stigma. Flowers: November-December.

Olearia axillaris (Fig. 14) Compositae

The smoky-grey bushes of *Olearia* are a conspicuous feature of coastal vegetation. This maritime shrub is found throughout the dunes and on limestone cliffs but is best developed in the coastal heath where it often dominates large areas of stable dune.

Shrub up to six feet with dense, soft, aromatic grey foliage. Leaves crowded, about 1 em. long and 1-3 mm. broad, oblanceolate to linear, margins entire and slightly recurved. Under surface with a fine white tomentum like the young stems, upper surface much

less so. Flower heads axillary, sessile, about 1 cm. long. Flowers few in each head, yellowish, surrounded by small white bracts. Flowers: February-April. Fruits with pappus of straw-coloured, spreading hairs.

Angianthus cunninghamii (Fig. 15) Compositae

This species is restricted to the seashore between Dirk Hartog Island and the Swan River. Its distribution is very patchy, some dune areas having frequent stands of it, others none.

An openly branched shrub about 18 in. high with both stems and leaves whitened by a fine, soft tomentum. Leaves spreading and slightly recurved, about 1.5 cm. long, oblong cuneate to linear and obtusely tipped. Flower heads in terminal racemes, ovoid-globose, 0.5 cm. diameter, the stalk leaves grading into bracts about the head. Flowers numerous, minute, deep yellow, in pairs surrounded by yellowish, membranous bracts. Flowers: February. Fruit with a deciduous, minute ring-like pappus.

The species is named in honour of Alan Cunningham, an English botanist who accompanied King on his survey voyage about Australia between 1812 and 1822. Cunningham discovered this species at Dirk Hartog Island.

Calocephalus brownii (Fig. 16) Compositae

This attractive cushion bush is found in the mobile dunes and in sandy pockets of limestone cliffs. It is endemic to the seashore of southern Australia.

Stems densely branched at wide angles, slender but rigid, a fine white tomentum completely obscuring the greenness of both stems and leaves. Leaves linear, up to 1.5 cm. long and about 1 mm. broad, pressed close to the stem. Flower heads globular, terminal on shoots, about 1.5 cm. diameter. Flowers tubular, yellow, in groups of 3 surrounded by white woolly bracts. Flowers: January-February. Fruit with a pappus of 10 plumose-ciliate scales.

Senecio lautus (Fig. 17) Compositae

Senecio is essentially a coastal heath plant but extends into sheltered hollows of the mobile dunes or establishes itself annually amongst the foliage of mat shrubs.

Annual or perennial loosely branched low bushes. Leaves simple linear or remotely toothed or deeply pinnatifid, stem clasping at the base, slightly succulent and light green. Flower heads about 2 cm. diameter, in flat-topped clusters, daisy-like, with spreading ray florets and compact disc florets, both yellow. Mature fruit with a pappus of fine, white spreading hairs.

The generic name is from the Latin, *senex*, an old man: alluding to the pappus; and *lautus*, splendid.

Arctotheca nivea (*Arctotis nivea*) (Fig. 18) Compositae

This plant is readily distinguished by its handsome greyish-white rosettes of foliage often thickly clustered just above high-



Fig. 17.—*Senecio lautus*

water mark of winter tides or on sand drifts throughout the dune-lands.

An annual or perennial with much-branched, fleshy prostrate stems expanding into rosettes of fleshy, ovate and slightly lobed leaves about 8 cm. diameter. The whole plant with a fine white tomentum often peeling from the upper surface of the leaves. Flower heads globular in bud stage, about 2 cm. diameter, on stout axillary stalks, daisy-like on opening. Flowers small, yellow, the short outer ray florets surrounding the crowded disc florets. Flowers: May-June. Fruits covered with a thin brown wool.

Arctotheca is native to sea shores of South Africa. It was first recorded on our coast at Bunbury about 1928 and has now spread along many miles of the coast.



Fig. 18.—*Arctotheca nivea*

Sonchus megalocarpus (Dune Thistle)

Compositae

This thistle is sparsely distributed through the mobile dune, usually in the shelter of mat shrubs. It differs from the common Sow Thistle, *Sonchus oleraceus* mainly in its perennial habit and coarser foliage. The tuberous root-stem stock proliferates new shoots each season.

Leaves stiff and leathery, more or less pinnatifid, with rounded, prickly-toothed lobes, the leaf bases clasping the stem with two rounded lobes. Flower heads in irregular corymbs, an involucre of bracts about 2 cm. long surrounding the numerous, yellow, ligulate flowers. Flowers: Spring and Summer. Fruits ovate-oblong, about 7 mm. by 3 mm. winged along the edges, smooth, surmounted by a pappus of fine white hairs.

This species is thought to be endemic in Australia and Tasmania, whereas *S. oleraceus* is cosmopolitan.

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A NEW SPECIES OF FROG OF THE GENUS
CRINIA

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1. INTRODUCTION

Moore (1954) using genetical isolation as a criterion for biological species, demonstrated the presence of a sibling (or morphologically indistinguishable) species of the genus *Crinia* Tschudi in Western Australia, namely *C. insignifera* Moore. This species had previously been included with *C. signifera* Girard as one morphological species, the latter species now being restricted to eastern Australia.

Main (1957) confirmed Moore's findings and showed that actually three sibling species rather than one had been included with *C. signifera*, on the basis of genetical isolation as indicated by *in vitro* crosses. The taxonomical position was then shown as two eastern species: *C. signifera* and *C. parinsignifera* Main; and two western species: *C. insignifera* and *C. pseudinsignifera* Main.